AD-A172 093 BISONAR SIGNAL PERCEPTION AND ANALYSIS(U) NORTH CAROLINA UNIV AT CHAPEL HILL DEPT OF ANATOMY O W HENSON 14 FEB 86 AFOSR-TR-86-0699 AFOSR-85-0063 1/1

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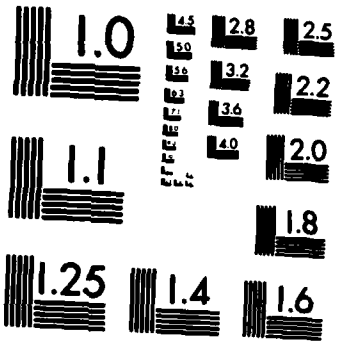

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This project has pursued behavioral, physiological and anatomical correlates of the biosonar system of bats. We have used a simulated flight system to record signal emissions and to analyze the response properties of the ear and brain centers in animals actively engaged in the imaging of specific targets. Much new information has been obtained, especially with respect to the potential importance of interference patterns (beats) in biosonar signal detection and analysis. Computer reconstruction techniques have been used to study FFT displays and various anatomical structures.

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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

DEPARTMENT OF ANATOMY

SWING BUILDING 217H

CHAPEL HILL, NORTH CAROLINA, 27514

Louise Harrison
Chief, Support Services Division
Director of Contracts
Airforce Office of Scientific Research
Bolling Air Force Base, Washington, D.C. 20332

February 10, 1984

Dear Ms. Harrison;

The following is a final report for an instrumentation grant (AFOSR-85-0063; control # 840513) which was awarded to Dr. O.W. Henson, Jr. All of the equipment ordered has now been received and is being used extensively in research experiments.

I. Equipment purchased

A. Video camera and tape recorder system
1. Sun Vision Co. 10" monitor $522.50
2. Sun vision TV color camera.....$4,911.50
3. Sun Vision video tape recorder $4,989.88

$10,423.88

B. Seven channel chart recording system

1. Gould Inc. SP110 amplifiers (3) and M200 character board $7,819.88

C. Digital oscilloscope

1. Tektronix Inc., digital oscilloscope model 5223 with plug in amplifiers model 5A22N & 5A26, time base. model 5B25N $10, 846.55

D. High speed, precision instrumentation tape recorder

1. Racal Inc., seven channel instrumentation tape recorder $22,833.25
44.87

$22,878.12

E. Image Analysis system

1. Data translation DMA analog input system.....$2070.82
2. Multiware Inc, MGSP/RT software.....$1,410.75
3. Eutectic Electronics Inc., Vector display processor and monitor. $13,245.37
4. Hewlett Packard 7090 plotter .....$ 4,598.00
5. Digital Equipment Corp. PDP-11/73 computer $12,044.67
6. Veytek, Summagraphics data tablet.....$936.87
7. Digital Equipment Corp., bit map graphics printer, terminal and keyboard.....$1998.04
8. Technical Manufacturing Corp., Micro-G table,.....$2105.68
9. Regan Controls, Inc. M57-51 Compumotor and driver $3,447.01
10. Hamilton-Avnet, computer A/D converter $855.90

$42,713.11

F. Operating microscope

1. Opelco, Fiber optic light guide and illuminator..... $569.84

2. Opelco, OME industrial microscope $4,556.72

$5126.56

G. High frequency, low noise amplifiers.

1. Princeton Applied Research, Model 113 preamplifiers $4,691.12

$104,499.22

software credit - -$83.51

104,415.71

Grant awarded $104,406.00
Amount spent $104,415.71
deficit $9.71
(deficit was paid for by other support)

II. CONCISE SUMMARY OF THE RESEARCH PROJECTS IN WHICH THE EQUIPMENT WILL BE USED.

A. SUMMARY OF PROJECTS -

1. STUDY OF BIOSONAR SIGNAL EMISSION BEHAVIOR BY BATS DURING SIMULATED FLIGHT. With our new equipment we have been able to build a new simulated flight system; the addition of our new video camera and tape system allows us to monitor the animals behavior and attentiveness to specific targets. We can also add or subtract stationary, moving or fluttering targets. To date we have shown that the bats always use a complex sonar signal that includes upward and downward sweeping, frequency modulated (FM) components and constant frequency (CF) components. We have also demonstrated that the bats Doppler shift compensate, echo intensity compensate and change the duration of their signals so that a specific amount of pulse-echo overlap occurs. When encountering fluttering objects during simulated flight their signal emissions are similar to those used by the bats in free flight.

2. STUDY THE RESPONSES OF THE AUDITORY SYSTEM TO NATURAL BIOSONAR SIGNALS IN BATS ACTIVELY ENGAGED IN THE ECHOLOCATION OF SPECIFIC TARGETS. This project is well underway and some parts of the project have been finished. By implanting electrodes chronically in the fluids of the inner ear we have established that the ear is poorly stimulated by the intense outgoing sonar signals but strongly stimulated by echoes which have been Doppler shifted upward. Beats created by pulse-echo interactions are prominent in cochlear microphonic potentials and this finding has raised many new questions concerning the processing of signals in bats which regulate their signals to assure that there are strong interference patterns created by mixing the pulses and returning echoes. Future studies will extend these observations to include a number of other species which utilize very different signals.

3. STUDY OF THE RESPONSES OF THE CENTRAL AUDITORY SYSTEM TO NATURAL SONAR SIGNALS DURING SIMULATED FLIGHT. Evoked neural potentials and single unit activity have been studied in peripheral and central auditory centers. Our evoked potential studies have utilized bats actively engaged in target imaging; single unit studies are currently focusing on the activity and response properties of single units in the CF and FM processing areas of the cerebral cortex. The data gathered are important for understanding how the nervous system codes biosonar information regarding target size, movement and shape. In future studies we will recreate the conditions that are now known to exist at the auditory periphery.

Tape recording of CM generated from intact animals will be supplied to other laboratories currently studying responses of single units in a variety of other auditory centers.

4. **STUDY OF THE EFFECT OF DRUGS ON BIOSONAR PERFORMANCE, AND PULSE AND ECHO-EVOKED EAR AND BRAIN POTENTIALS DURING SIMULATED FLIGHT. These experiments are just beginning but will be of major importance to experiments designed to study the transmit-receive mechanisms of the bat's biosonar system. Studies are currently focusing on the effect of atropine on CM potentials so that the physiological influence of the efferent auditory system can be established.**

5. **COMPUTER SOFTWARE DEVELOPMENT FOR ANALYZING BIOSONAR SIGNALS AND NEUROPHYSIOLOGICAL RESPONSES OF THE EAR AND CNS. Our studies require rapid processing of frequency and amplitude data and we have written new computer programs for rapidly processing the specific types of data that we need. Furthermore, the transfer of digitized data to our new image analysis system allows us to rotate FFT displays in real time and to rotate zoom FFTs for high resolution.**

6. 3-D RECONSTRUCTION AND ROTATION OF ANATOMICAL STRUCTURES IN THE EAR AND BRAIN. These studies deal with structural mechanisms associated with fine frequency resolution by the ear. To date we have made 3-D reconstructions from 60.0 um, 30.0 um, 2.0 um and 0.08 um **serial sections through specific ear structures. We have** uncovered a wealth of new data concerning the changing size and shapes of structures and the afferent and **efferent innervation patterns of cochlear hair cells. Future studies will be directed toward quantifying the** density of newly discovered contractile cells in the lateral wall of the cochlea.

B. SUPPORT OF RESEARCH WORK DESCRIBED IN THE PROPOSAL

1. NIH grant (NS 12445) - Mechanisms of acoustic perception and orientation.

2. NIH grant (NS 19031) - The efferent auditory system and signal analysis.

C. OTHER RESEARCH WORK OF INTEREST TO DoD.

none

O.W. Henson, Jr
Professor of Anatomy

END

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